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Volcanic sanidinites: an example for the mobilization of high field strength elements (HFSE) in magmatic systems

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In earth science the mobility of high field strength elements (HFSE) is generally discussed in context of hydrothermal processes. Recent investigations mainly address processes in (late) magmatic-, metamorphic- and submarine hydrothermal systems. They have all in common that H_2O is main solvent. The transport of HFSE is suggested to be favored by volatiles, like boron, fluorine, phosphate and sulfate (Jiang et al., 2005).
In this study processes in magmatic system are investigated. Sanidinites are rare rocks of igneous origin and are found as volcanic ejecta of explosive volcanoes. They consist mainly of sanidine and minerals of the sodalite group. The very porous fabric of these rocks is an indication of their aggregation from a gaseous magmatic phase. The large sanidine crystals (up to several centimeters) are mostly interlocking, creating large cavities between some crystals. In these pores Zr crystallizes as oxide (baddeleyite, ZrO_2) or silicate (zircon, ZrSiO4). The euhedral shape of these minerals is a further indication of their formation out of the gas phase. Furthermore, bubbles in glass observed in some samples are evidence for gas-rich reaction conditions during the formation of the sanidinites.
The formation of sanidinites is suggested to be an example for solvothermal processes in natural systems. Solvothermal processes imply the solvation, transport and recrystallization of elements in a gas phase. Results obtained from whole rock analysis from sanidinites from Laacher See (Germany) show a positive correlation between LOI, sulfate, Cl, and Na with the HFSE like Zr. Na-rich conditions seem to ameliorate the solvothermal transport of Zr. All these features point to the formation of sanidinites in the upper part of a magma chamber, where fluid consisting of SO_3 and Cl compounds in addition to H_2O, CO_2 and HFSE (high field strength elements) like Zr accumulate.